

Chapter 10: Chemical Quantities

Section 10.1 The Mole: A Measurement of Matter (pg.287-296)

1. Determine the quantity of a substance by count, mass, or volume.
2. Define a mole.
3. Determine the mass of a mole of a compound.

Section 10.2 Mole-Mass and Mole-Volume Relationships (pg. 297-303)

1. Calculate the mass of a substance given a molar quantity and vice versa.
2. Define Avogadro's hypothesis.
3. Calculate the volume of a gas (at STP) given a molar quantity and vice versa.
4. Calculate molar mass from density.

Section 10.3 Percent Composition and Chemical Formulas (pg. 305-312)

1. Determine the percent composition of a substance given a chemical formula or mass data.
2. Determine the empirical formula of a compound.
3. Determine the molecular formula of a compound.

Written Work

p. 315-318 # 49c, 50, 58a,c,e, 59a,c,e, 61, 63a, 64a, 68, 72, 73, 74, 75a, 77, 78, 80, 81, 83, 86,
88, 89, 90, 92, 98, 101, 110, 111, 112
p. 319 # 2-14 even

Chapter 10 Supplemental Questions

1. Compare the number of square miles that land covers the earth ($57,491,000 \text{ mi}^2$) to the area that a mole of corn cobs would cover if, on average, there are three cobs per stalk and a total of 8 stalks are planted per square yard. Other conversion factors that you might find helpful would be:
 $1 \text{ yd}^2 = 2.1 \times 10^{-4} \text{ acres}$ and $1 \text{ acre} = 1.6 \times 10^{-3} \text{ mi}^2$. (Please solve this problem using the factor label method)

2. Read the article found at <http://www.scientificamerican.com/article.cfm?id=how-was-avogadros-number> and answer the following questions:
 - a. What is Avogadro's hypothesis?

 - b. Prior to the determination of the accepted value of a mole (6.02×10^{23}) two less accurate methods were used to determine that value. What method did each of the following scientists employ:
 - i. Loschmidt

 - ii. Perrin

 - c. Which atomic theorist, from your chapter 4 supplemental questions, accurately determined the value of a mole?

3. The word empirical is an adjective that describes something that is derived from experiment and observation rather than theory. In theory, we can predict the outcome of a chemical reaction, but it is really experimental data that completely describes what occurred in reality.



The reaction above shows two possible products that can result from the reaction of elemental iron and oxygen. Given the following empirical data, answer questions a-c.W

When 10 grams of iron are completely oxidized by oxygen, 12.9g of one of the iron oxide compounds above is produced.

- a. How much oxygen was used to oxidize the iron?

- b. What is the percent composition of both iron and oxygen in product of the reaction?

- c. Which of the products listed above resulted from the empirical data?

4. A hydrocarbon compound contains 83.6% carbon and 16.4% hydrogen by mass. The molecular mass of the compound is 86.2 g.
- What is the empirical formula of the compound?
 - What is the molecular formula of the compound?

Examine the table containing a variety of hydrocarbon compounds called alkanes and answer the questions to the right:

Name of Alkane	Chemical Formula	Boiling Point in °C	Melting Point in °C
Methane	C ₁ H ₄	-162	-183
Ethane	C ₂ H ₆	-89	-172
Propane	C ₃ H ₈	-42	-188
<i>n</i> -Butane	C ₄ H ₁₀	0	-138
<i>n</i> -Pentane	C ₅ H ₁₂	36	-130
<i>n</i> -Hexane	C ₆ H ₁₄	69	-95
<i>n</i> -Heptane	C ₇ H ₁₆	98	-91

c. What is the physical state of the molecular compound at room temperature?

d. What is the relationship between the number of carbon atoms in an alkane and the melting point of alkanes?

5. Determining the percent composition of matter has several valuable applications in the real world. One important application is in the field of forensics, specifically soil analysis.

"Soil is not just plain dirt. It is a conglomerate of several things. They include minerals, plants, animal matter, and tiny particulates of synthetic products like glass, paint, asphalt, cement, and other things. The contents of soil are not uniform wherever you go. They differ from one place to another. Soil found on the beach in Ocean City, Maryland has different components from soil found on the beach in Myrtle Beach, South Carolina" Article Source: <http://EzineArticles.com/1113212>

A 15.0g soil sample was collect from tire tracks at a crime scene in Upper Dublin PA. The sample contained the following elemental content: 7.35g of oxygen, 4.65g of silicon, 1.08g of aluminum, 0.39g of iron and 1.53g of other elements.

Examine the information in the table below

Location	Sample Size	Oxygen (g)	Silicon (g)	Aluminum (g)	Iron (g)	Other elements (g)
Horsham	25.0 g	7.75	12.25	1.80	0.65	2.55
Abington	35.0 g	17.15	10.85	2.52	0.91	3.57
Upper Dublin	50.0 g	24.5	15.5	1.30	3.60	5.10

Did the dirt from the tire tracks originate in Upper Dublin, or did the dirt come from somewhere else?

If it came from somewhere else, given the data above, where is the most likely origin of the dirt?

Mole Conversion Worksheet

There are three mole equalities. They are:

$$1 \text{ mol} = 6.02 \times 10^{23} \text{ particles}$$

$$1 \text{ mol} = \text{molar mass (periodic table)}$$

$$1 \text{ mol} = 22.4 \text{ L for a gas at STP}$$

Mole-Particle Conversions

1. How many moles of magnesium is 3.01×10^{22} atoms of magnesium?
2. How many molecules are there in 4.00 moles of glucose, $\text{C}_6\text{H}_{12}\text{O}_6$?
3. How many moles are 1.20×10^{25} atoms of phosphorous?
4. How many atoms are in 0.750 moles of zinc?
5. How many molecules are in 0.400 moles of N_2O_5 ?

Mole-Mass Conversions

6. How many moles in 28 grams of CO_2 ?
7. What is the mass of 5 moles of Fe_2O_3 ?
8. Find the number of moles of argon in 452 g of argon.
9. Find the grams in 1.26×10^{-4} mol of $\text{HC}_2\text{H}_3\text{O}_2$.
10. Find the mass in 2.6 mol of lithium bromide.

Mole-Volume Conversions

11. Determine the volume, in liters, occupied by 0.030 moles of a gas at STP.
12. How many moles of argon atoms are present in 11.2 L of argon gas at STP?
13. What is the volume of 0.05 mol of neon gas at STP?
14. What is the volume of 1.2 moles of water vapor at STP?

Molar Mass- Density Conversions (at STP)

15. What is the density of the following compounds at STP?
 - a. C_2H_4
 - b. He
 - c. CO_2
16. The density of a gas is 2.5 g/L at STP. What is the mass of this gas?
17. The density of a gas at STP is 0.75 g/L. What is the mass of this gas?

Mixed Mole Conversions

Given unit \rightarrow Moles \rightarrow Desired unit

18. How many oxygen molecules are in 3.36 L of oxygen gas at STP?
19. Find the mass in grams of 2.00×10^{23} molecules of F_2 .
20. Determine the volume in liters occupied by 14 g of nitrogen gas at STP.
21. Find the mass, in grams, of 1.00×10^{23} molecules of N_2 .

Percent Composition Worksheet

Find the percent compositions of all of the elements in the following compounds:



Cu: _____

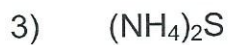
Br: _____



Na: _____

O: _____

H: _____



N: _____

H: _____

S: _____



N: _____

S: _____

5) KMnO_4

K: _____

Mn: _____

O: _____

6) HCl

H: _____

Cl: _____

7) $\text{Mg}(\text{NO}_3)_2$

Mg: _____

N: _____

O: _____

7) $(\text{NH}_4)_3\text{PO}_4$

N: _____

H: _____

O: _____

P: _____

8) $\text{Al}_2(\text{SO}_4)_3$

Al: _____

S: _____

O: _____

Name: _____

Empirical Formula Practice Problems

Determine the empirical formula for the compounds below.

1.) 75% carbon, 25% hydrogen

2.) 52.7% potassium, 47.3% chlorine

3.) 22.1% aluminum, 25.4% phosphorus, 52.5% oxygen

4.) 13% magnesium, 87% bromine

5.) 32.4% sodium, 22.5% sulfur, 45.1% oxygen

6.) Freons are gaseous compounds used in refrigeration. A particular freon contains 9.93% Carbon, 59% Chlorine and 31.07% Fluorine. What is the empirical formula?

7.) A compound consists of 85% silver and 15% fluorine by mass. What is the empirical formula?

8.) A compound consists of 40% calcium, 12% carbon and 48% oxygen by mass. What is the empirical formula by mass?

9.) A compound contains 50% Magnesium, 24% carbon, 10% hydrogen, and 16% oxygen. What is the empirical formula?

10.) Benzoic acid contains 68.8% Carbon, 4.95% Hydrogen and 26.2% Oxygen. Find the empirical formula.

11.) A compound contains 25.3% copper, 12.9% sulfur, 25.7% oxygen, and 36.1% water (This formula is written as a hydrate).

1. Benzene, a non-polar solvent used for many applications in industry, and a major component in many organic compounds has the following percent composition:

$$\text{C} = 92.3\%$$

$$\text{H} = 7.8\%$$

a. Find Benzene's empirical formula.

b. Find the Molecular formula of benzene if the entire formula mass is 78.12 g/mol

2. An unknown sugar is found to have a formula mass of 180.18 g/mol. The sugar contains:

$$40.0\% \text{ C}, 6.7\% \text{ H and } 53.3\% \text{ O}.$$

a. Find the empirical and molecular formula of this sugar. b. What's its name?

3. Tryptophan – the chemical in turkey that is believed to make you sleepy – has the empirical formula $\text{C}_{11}\text{H}_{12}\text{N}_2\text{O}_2$.

Find the molecular formula if the formula mass is 204.25 g/mol.

4. Caffeine is made of 49.48 % C, 5.19% H, 16.48% O and 28.8% N. Find the molecular mass of Caffeine if its overall molecular mass is 194.22 g/mol

5. Hydrogen peroxide is 5.93 % H and 94.07 % O. Find the formula of hydrogen peroxide given it has an overall formula mass of 34 g/mol.

6. A strong oxidizing agent and rocket propellant has a % composition of 30.43% N and 69.57 % O. Find the molecular formula if its formula mass is 92.0 g/mol.